A PROJECT REPORT

ON

FACE RECOGNITION SYSTEM WITH FACE DETECTION

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In Computer Science Engineering

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Abstract

The face is one of the easiest ways to distinguish the individual identity of each other. Face Recognition is a personal identification system that uses personal characteristics of a person to identify the person's identity. Face recognition presents a challenging problem in the field of image analysis and computer vision. Face recognition has become more significant and r elevant in recent years owing to it potential applications. Since the faces are highly dynamic and pose more issues and challenges to solve, researchers in the domain of pattern cognition, computer vision and artificial intelligence have proposed many solutions to reduce such diff iculties so as to improve the robustness and recognition accuracy. As many approaches have been proposed, efforts are also put in to provide an extensive survey of the methods develop ed over the years. The objective of this paper is to provide a survey of face recognition pape rs that appeared in the literature over the past decade under all severe conditions that were n ot discussed in the previous survey and to categorize them into meaningful approaches, viz. appearance based, feature based and soft computing based. A comparative study of merits an d demerits of these approaches have been presented.

Keywords: Face recognition; feature based; appearance based; soft computing based; Gabor
patterns; fuzzy based; genetic algorithm; non-tensor wavelets; sparse representation

Introduction

Face recognition is one of the most popular applications of image analysis. In present scenar io, face recognition plays a major role in security, personal information accesses, improved h uman machine interaction and personalized advertising. Hence a recognition system that, is i nexpensive to use at any location, performs quicker matching, handles large database and do recognition in a varying environment is the need of the hour. It is a true challenge to build a n automated system which parallel human ability to recognize faces. It is a biometric approa ch that employs automated methods to verify or recognize the identity of a living person bas ed on his /her physiological characteristics. Although humans are quite good in identifying k nowfaces, it is very hard to deal with a large amount of unknown faces. This human limitati on is overcome by super computers using strong algorithms. For many applications, the perf ormance of face recognition systems in controlled environments has now reached a satisfact ory level; however, there are still many challenges posed by uncontrolled environments. So me of these challenges are posed by the problems caused by variations in illumination, face pose, expression, etc. The erect of variation in the illumination conditions in particular, whic h causes dramatic changes in the face appearance, is one of those challenging problems that a practical face recognition system needs to face. Moreover, in a practical application enviro nment the illumination variation is always coupled with other problems such as pose variatio n and expression variation, which increase the complexity of the automatic face recognition problem. Over the past 15 years, research has focused on how to make face recognition syste ms fully automatic by tackling problems such as localization of a face in a given image or vi deo clip and extraction of features such as eyes, mouth, etc. Meanwhile, significant advances have been made in the design of classier for successful face recognition. Among appearance based holistic approaches, Eigenfaces and Fisher faces have proved to be erective in experim ents with large databases. Featurebased graph matching approaches have also been quite suc cessful. Compared to holistic approaches, featurebased methods are less sensitive to variatio ns in illumination and viewpoint and to inaccuracy in face localization. However, the feature extraction techniques needed for this type of approach are still not reliable or accurate enou gh. Face recognitions can also be done by using soft computing tools. Neural networks, Fuzz y logic and Genetic algorithm (GA) are frequently used soft computing techniques. Compare d to all the other methods, soft computing techniques are time consuming processes. Though , a variety of techniques have already surfaced for face recognition problem, it is yet a devel oping depending on the application scenario and scene constraints. Such a proliferating requi res review of techniques available as on today to enable designers to choose from. The earlie r literature available on survey of face recognition techniques broadly include statistical-based, holisticbased, featurebased and artificial intelligencebased approaches. This current w ork encompasses some of the recent techniques viz., hybrid approaches, fuzzy based approaches and optimization-based approaches applicable to challenging scenario like variation in illumination conditions, pose orientations, facial expressions and low-quality images

Literature Review

This section gives an overview on the major human face recognition techniques that apply m ostly to frontal faces, advantages and disadvantages of each method are also given. The meth ods considered are eigenfaces (eigenfeatures), neural networks, dynamic link architecture, hi dden Markov model, geometrical feature matching, and template matching. The approaches are analysed in terms of the facial representations
they used

A. Eigenfaces

Eigenface is one of the most thoroughly investigated approaches to face recognition. It is a lso known as Karhunen-
Loève expansion, eigen picture, eigen vector, and principal component. used principal comp onent analysis to efficiently represent pictures of faces. They argued that any face images co uld be approximately reconstructed by a small collection of weights for each face and a stan dard face picture (eigen picture). The weights describing each face are obtained by projectin g the face image onto the eigen picture used eigen faces, which was motivated by the techni que of Kirby and Sirovich, for face detection and identification.

B. Neural Networks

The attractiveness of using neural networks could be due to its non-
linearity in the network. Hence, the feature extraction step may be more efficient than the lin ear KarhunenLoève methods. One of the first artificial neural networks (ANN) techniques used for face recognition is a single layer adaptive network called WISARD which contains a separate network for each stored individual. The way in constructing a neural network stru cture is crucial for successful recognition. It is very much dependent on the intended applic ation. For face detection, multilayer perceptron and convolutional neural network have been applied. For face verification, is a multi-
resolution pyramid structure. proposed a hybrid neural network which combines local image sampling, a self-
organizing map (SOM) neural network, and a convolutional neural network. The SOM pro vides a quantization of the image samples into a topological space where inputs that are near by in the original space are also nearby in the output space, thereby providing dimension red uction and invariance to minor changes in the image sample. The convolutional network extr acts successively larger features in a hierarchical set of layers and provides partial invariance to translation, rotation, scale, and
deformation

C. Graph Matching

Graph matching is another approach to face recognition presented a dynamic link structure f or
distortion invariant object recognition which employed elastic graph matching to find the cl osest stored graph. Dynamic link architecture is an extension to classical artificial neural networks. Memorized objects are represented by sparse graphs, whose vertices are labelled w ith a multiresolution description in terms of a local power spectrum and whose edges are labe lled with geometrical distance vectors. Object recognition can be formulated as elastic graph matching which is performed by stochastic optimization of a matching cost function.

D. Hidden Markov Models (HMMs)

Stochastic modelling of nonstationary vector time series based on (HMM) has been very s uccessful for speech applications applied this method to human face recognition. Faces were intuitively divided into regions such as the eyes, nose, mouth, etc., which can be associated

with the states of a hidden Markov model. Since HMMs require a one-dimensional observation sequence and images are two-dimensional, the images should be converted into either 1D temporal sequences or 1D spatial sequences

E. Geometrical Feature Matching

Geometrical feature matching techniques are based on the computation of a set of geometric al features from the picture of a face. The fact that face recognition is possible even at coars e resolution as low as 8x6 pixels when the single facial features are hardly revealed in detail, implies that the overall geometrical configuration of the face features is sufficient for recog nition. The overall configuration can be described by a vector representing the position and size of the main facial features, such as eyes and eyebrow, nose, mouth, and the shape of fa ce outline.

F. Template Matching

A simple version of template matching is that a test image represented as a two-dimensional array of intensity values is compared using a suitable metric, such as the Euclidean distance, with a single template representing the whole face. There are several other more sophisticated versions of template matching on face recognition. One can use more than one face template from different viewpoints to represent an individual's face. A face from a single viewpoint can also be represented by a set of multiple distinctive smaller templates [49,52]. The face image of gray levels may also be properly processed before matching [53]. In [49], Bruneli and Poggio automatically selected a set of four features templates, i.e., the eyes, nose, mouth, and the whole face, for all of the available faces. They compared the performance of their geometrical matching algorithm and template matching algorithm on the same database of faces which contains 188 images of 47 individuals. The template matching was superior in recognition (100 percent recognition rate) to geometrical matching (90 percent recognition rate) and was also simpler.

Proposed Methodology

Below are the methodology and descriptions of the applications used for data gathering, face detection, face recognition. The project was coded in Python using a mixture of IDLE and PyCharm IDEs.

Face Detection.
First stage was creating a face detection system using Haar-cascades. Although, training is required for creating new Haar-cascades, OpenCV has a robust set of Haar-cascades that was used for the project. Using face-cascades alone caused random objects to be identified and eye cascades were incorporated to obtain stable face detection. The flowchart of the detection system can be seen in figure 1.

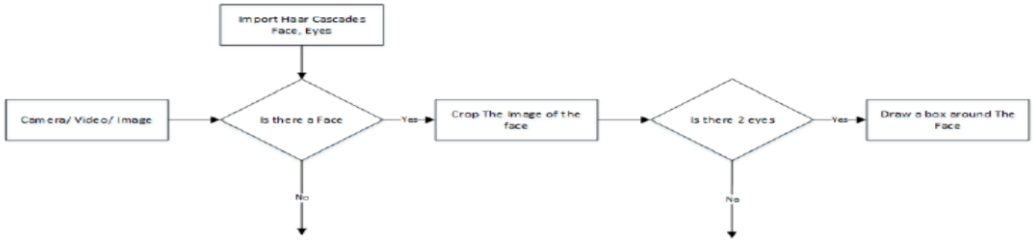


Figure 1. The Flow chart of the face detection application.

classifier objects are created using classifier class in OpenCV through the. CascadeClassifier( ) and loading the respective XML files. A camera object is created using the cv2.VideoCaptu re() to capture images. By using the Cascade Classifier detectMultiScale() object of various s izes are matched and location is returned. Using the location data, the face is cropped for fur ther verification. Eye cascade is used to verify there are two eyes in the cropped face. If satis fied a marker is placed around the face to illustrate a face is detected in the location.

For this project three algorithms are implemented independently. These are Eigenface, Fishe rface and Linear binary pattern histograms respectively. All three can be implemented using OpenCV libraries. There are three stages for the face recognition as follows:
1. Collecting images IDs
2. Extracting unique features, classifying them and storing in XML files
3. Matching features of an input image to the features in the saved XML files and predict ide ntity.

Collecting Image data
Collecting classification images is usually done manually using a photo editing software to c rop and resize photos. Furthermore, PCA and LDA requires the same number of pixels in all the images for the correct operation. This time consuming and a laborious task is automated through an application to collect 50 images with different expressions. The application detec ts suitable expressions between 300ms, straightens any existing tilt and save them. The Flow chart for the application is shown in figure 2

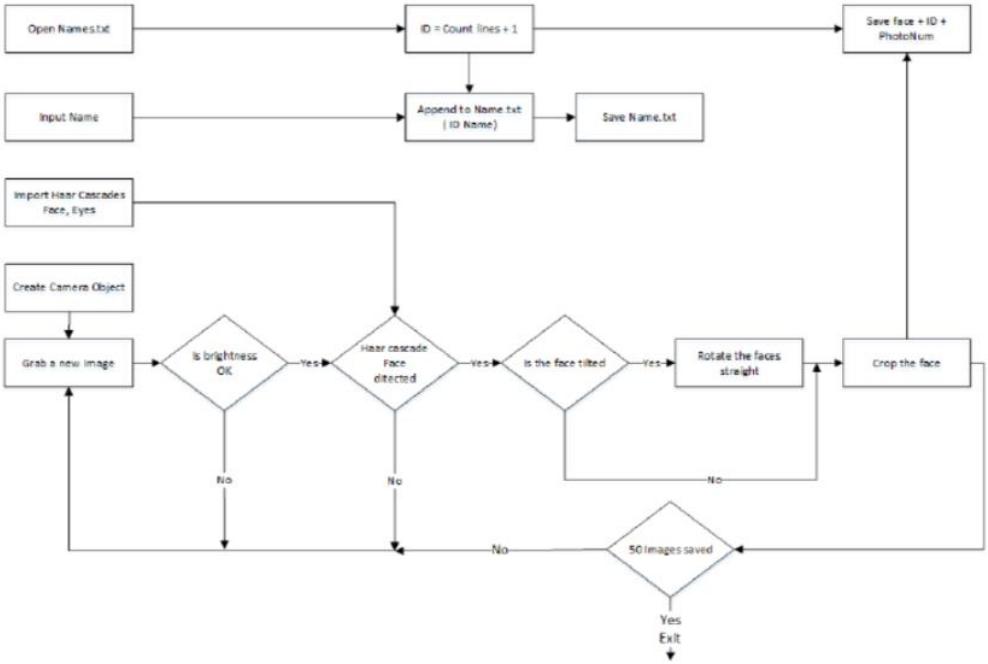


Figure 2. The Flowchart for the image collection

Application starts with a request for a name to be entered to be stored with the ID in a text fi le. The face detection system starts the first half. However, before the capturing begins, the a pplication check for the brightness levels and will capture only if the face is well illuminated . Furthermore, after the face is detected, the position of the eyes is analysed. If the head is til ted, the application automatically corrects the orientation. These two additions were made co nsidering the requirements for Eigenface algorithm. The Image is then cropped and saved us ing the ID as a filename to be identified later. A loop runs this program until 50 viable image s are collected from the person. This application made data collection efficient

Face Recognition

Face recogniser object is created using the desired parameters. Face detector is used to detec t faces in the image, cropped and transferred to be recognised. This is done using the same te chnique used for the image capture application. For each face detected, a prediction is made using FaceRecognizer.predict() which return the ID of the class and confidence. The process is same for all algorithms and if the confidence his higher than the set threshold, ID is -

1. Finally, names from the text file with IDs are used to display the name and confidence on the screen. If the ID is -

1, the application will print unknown face without the confidence level. The flow chart for th e application is shown in figure 3

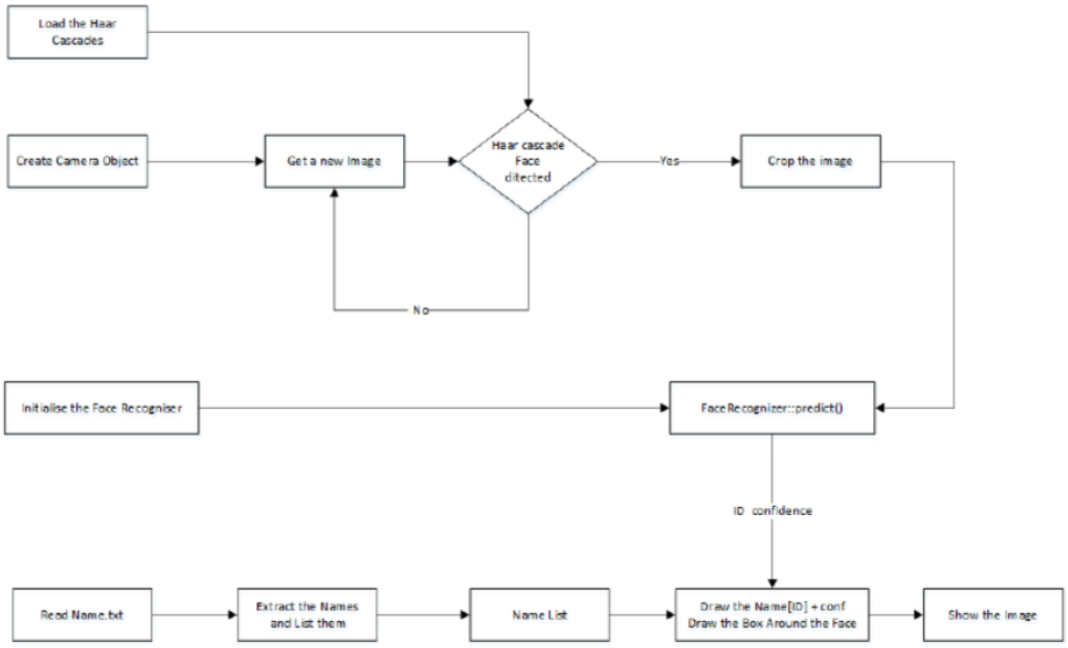
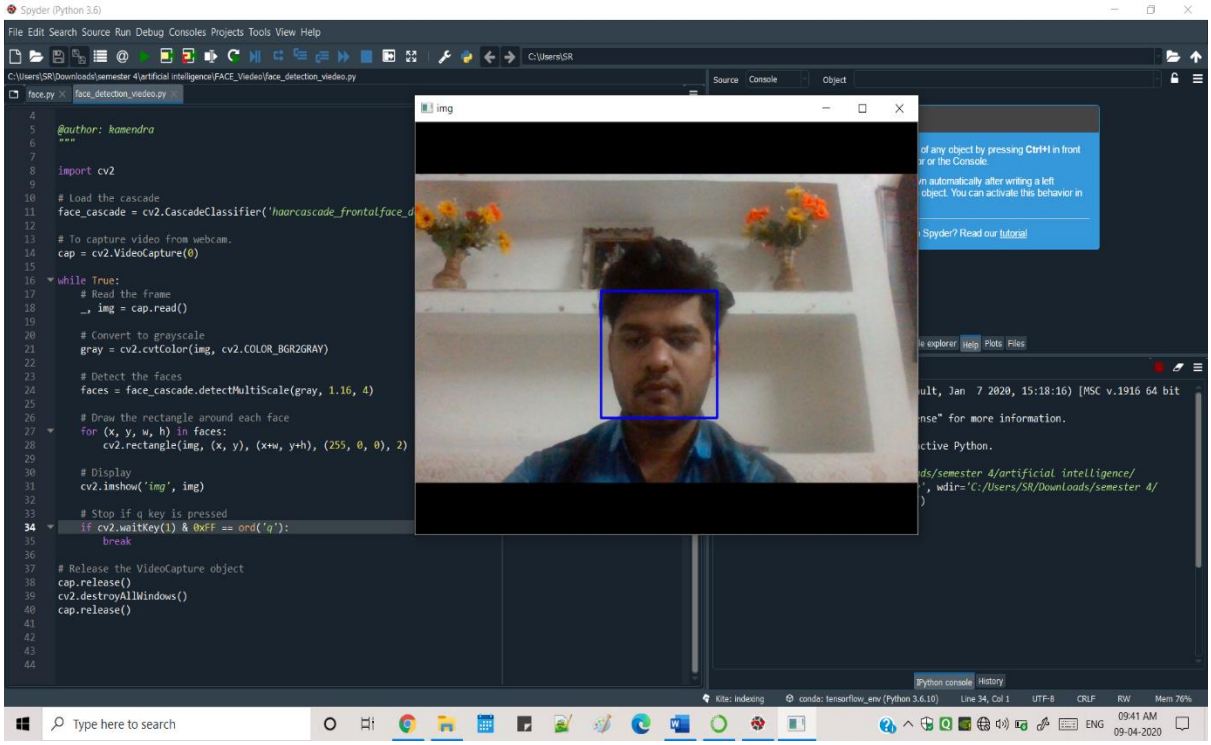


Figure 3 Flowchart of the face recognition application

Result


Spyder (Python 3.6)
File Edit Search Source Run Debug Consoles Projects Tools View Help
face.py
face_detection_viedeo.py
@author: kamendra
import cv2
# Load the cascade
face_cascade = cv2.CascadeClassifier('haarcascade_frontalface_d
# To capture video from webcam.
cap = cv2.VideoCapture(0)
while True:
# Read the frame
_, img = cap.read()
# Convert to grayscale
gray = cv2.cvtColor(img, cv2.COLOR_BGR2GRAY)
# Detect the faces
faces = face_cascade.detectMultiScale(gray, 1.16, 4)
# Draw the rectangle around each face
for (x, y, w, h) in faces:
cv2.rectangle(img, (x, y), (x+w, y+h), (255, 0, 0), 2)
# Display
cv2.imshow('img', img)
# Stop if q key is pressed
if cv2.waitKey(1) & 0xFF == ord('q'):
break
# Release the VideoCapture object
cap.release()
cv2.destroyAllWindows()
cap.release()
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Conclusion

This paper describes the mini-
project for visual perception and autonomy module. Next, it explains the technologies used i n the project and the methodology used. Finally, it shows the results, discuss the challenges and how they were resolved followed by a discussion. Using Haarcascades for face detection worked extremely well even when subjects wore spectacles. Real time video speed was satis factory as well devoid of noticeable frame lag. Considering all factors, LBPH combined with Haarcascades can be implemented as a cost effective face recognition platform. An example is a system to identify known troublemakers in a mall or a supermarket to provide the owner a warning to keep him alert or for automatic attendance taking in a class.

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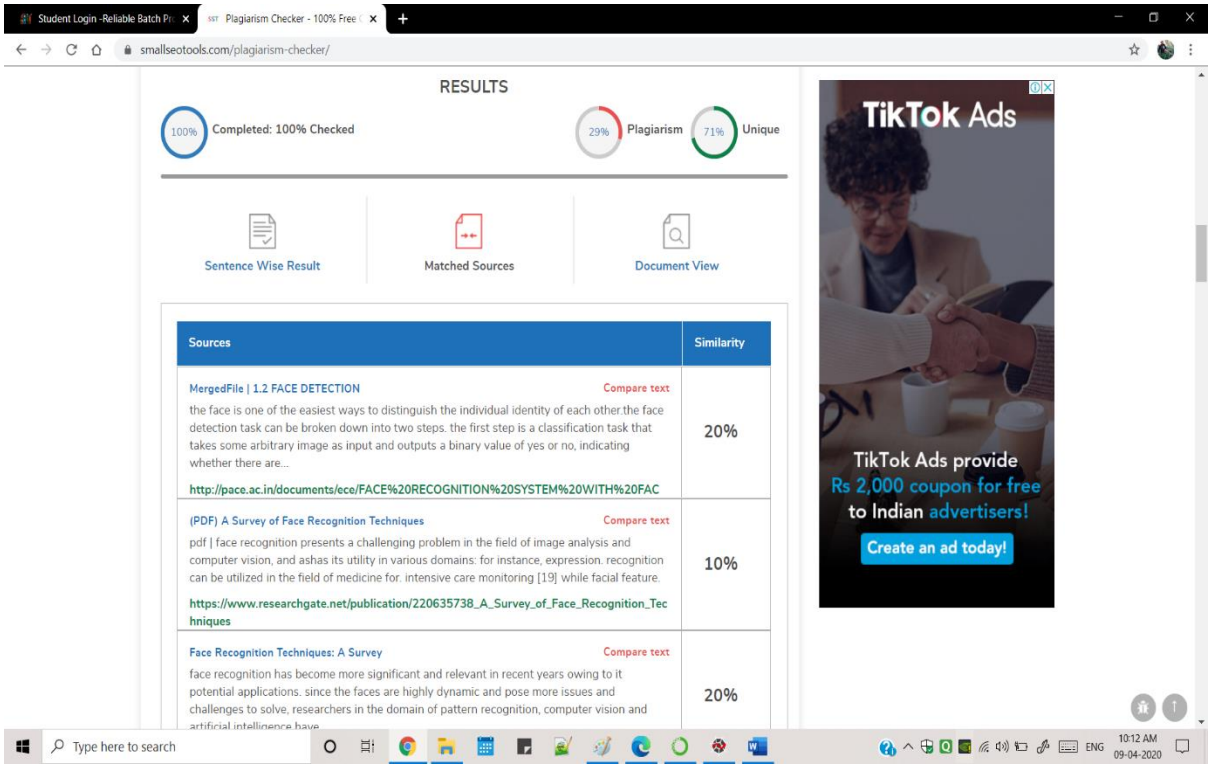
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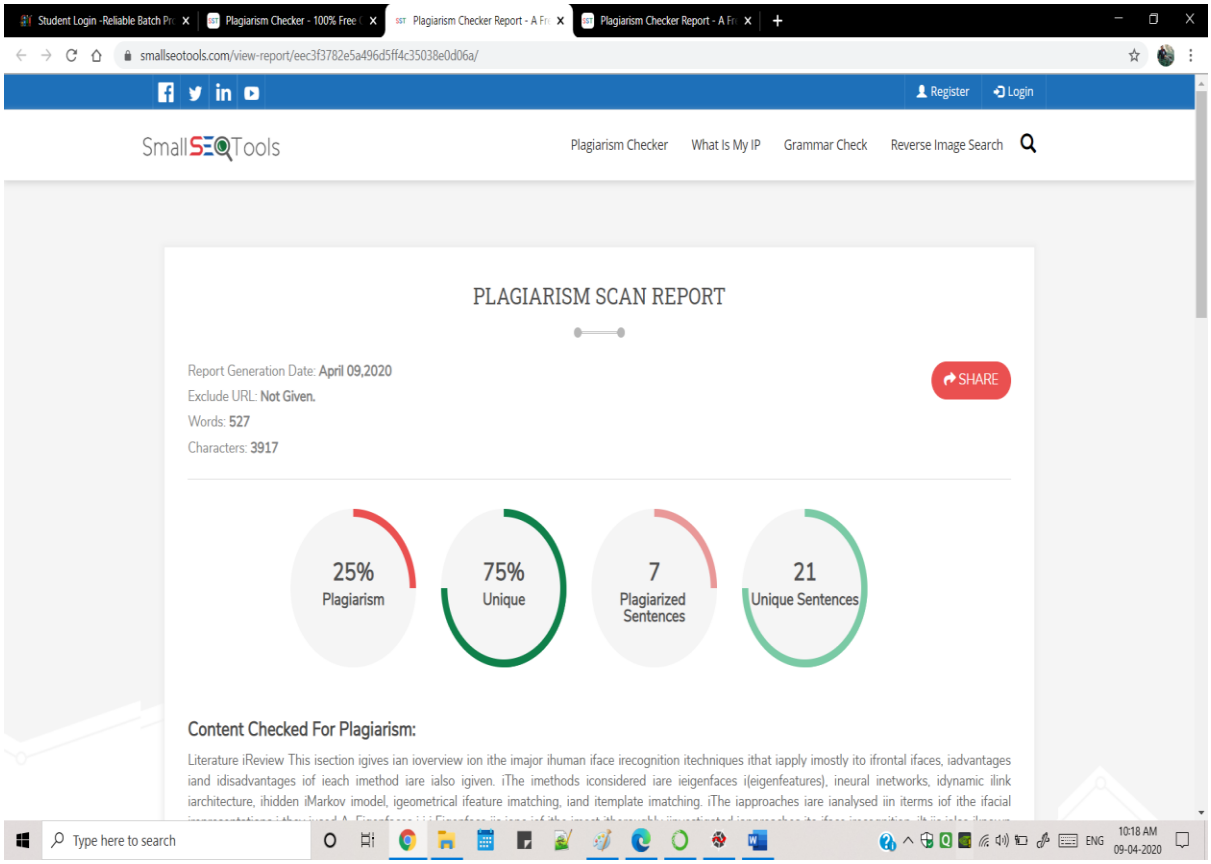
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